

# **Nanofab Laboratory Usage Manual**

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9/6/2006**



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## 1. INTRODUCTION

To continue to respond to U.S. science and industry's needs for more sophisticated measurements and standards in the face of heightened global competition, NIST has constructed one of the most technologically advanced facilities in the world—the Center for Nanoscale Science and Technology, or CNST. The NIST CNST Nanofab is one of five buildings in the Advanced Measurement Laboratory at the Gaithersburg, MD campus. The CNST Nanofab will provide researchers at NIST working on a variety of semiconductor and other nanotechnology research the ability to fabricate prototypical nanoscale test structures, measurement instruments, standard reference materials, and electronic devices.

The NIST Center for Nanoscale Science and Technology (CNST) Nanofab will:

- enable fabrication of prototypical nanoscale test structures, measurement instruments, standard reference materials, electronic devices, MEMS, and bio-devices critical to NIST's Strategic Focus Areas (Nanotechnology, Homeland Security, Healthcare) and the Nation's Nanotechnology Needs
- provide access to expensive nanofabrication tools, technologies and expertise in a shared-access, shared-cost environment to NIST and its partners
- foster internal collaboration in Nanotechnology across NIST's Laboratories
- foster external collaboration in Nanotechnology with NIST's partners.

The NIST CNST Nanofab has approximately 1000 m<sup>2</sup> (10,000 sq-ft) of Class 100 bay and chase, cleanroom space with extremely wide Class 1000 equipment corridors. NIST has invested in a complete suite of new state-of-art semiconductor equipment (capable of processing 150 mm wafers and various sizes of samples) that includes:

- ATM furnaces (2 banks of 4 tubes each)
- LPCVD (poly, nitride, LTO)
- PECVD
- Rapid Thermal Annealer
- 4 Reactive Ion Etchers (SF<sub>6</sub>/O<sub>2</sub>, Metal RIE, Metal ICP, Deep Silicon)
- Microwave Asher
- Critical Point Dryer
- 5 Metal deposition tools (thermal, e-beam, sputter)
- 3 Contact Mask Aligners (front- and back-side alignment)
- 2 E-beam lithography systems
- Focused Ion Beam
- Nanoimprint Lithography
- Inspection (FE-SEM Zeiss Ultra 60)
- Metrology Tools (Spectroscopic Ellipsometer, Contact Profilometer, 4-point probe station, Nikon Optical microscope with image capture, etc.).
- Wafer Dicing Saw

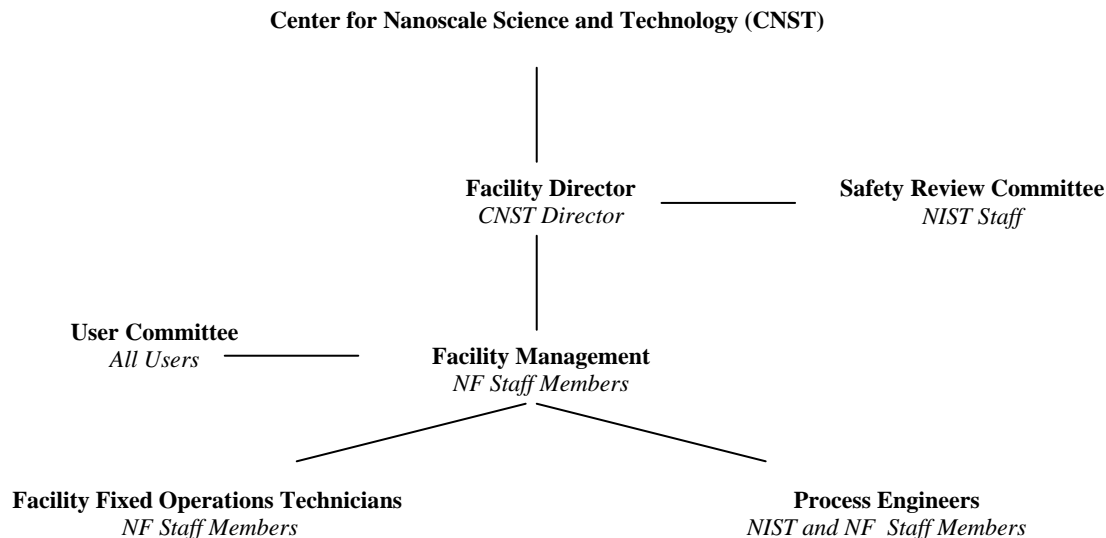
▪ *Note: for up to date equipment lists see the nanofab website at [nanofab.cnst.nist.gov](http://nanofab.cnst.nist.gov).*

The Nanofab will be operated as shared access user facility. This means that the staff of NIST and its partners, subject to provisions, training, and user fees, will be permitted to independently operate the equipment. The tools will be operated in a manner such that a wide variety of materials can be processed. The facility will be directed by NIST's Center for Nanoscale Science and Technology. Unlike other Nanofabs, the NIST CNST Nanofab is unique in that it is located next to the most advanced metrology tools in the world, and its focus will be on fabricating nanoscale structures necessary for metrology and standards in support of the semiconductor industry, nanotechnology, biotechnology, and homeland security.

This Laboratory Manual describes the organization and general procedures related to the facility. Section 2 describes the management of the facility and the types of facility users. Section 3 describes general procedures for using the facility including new user access, a description of the facility layout, facility governance, visitors, and publication policies. Section 4 describes cost structures and fees for using the facility. Section 5 describes policies associated with equipment including guidelines for operating procedure development and revision, equipment training, scheduling, modification, repair, installation, maintenance, consumables, and a description of equipment capabilities. There are separate manuals describing the operation of each individual tool. Section 6 describes general procedures associated with safety including responsibilities and authorities. A separate Safety Manual for the facility exists that describes safety issues in detail. Contact information for facility management and super users is given in the Section 7 Appendix. A facility web site (<http://nanofab.cnst.nist.gov>) also contains a description of the facility.

## 2. ORGANIZATION OF THE NANOFAB

The NIST CNST Nanofab is managed for NIST by the CNST Nanofab Facility Group. This section describes the organization of the management of the facility and the types of users. Contact information for facility management is given in the Section 7 Appendix.



### 2.1 Nanofab Manager

The Facility Manager is named by the Director of the Center for Nanoscale Science and Technology and is formally responsible for all aspects of the operation and safety of the facility. The Facility Manager is the supervisor of the Facility Staff. The Facility Manager is responsible for the budget of the facility, marketing the facility, and developing a user-base for the facility.

### 2.2 Nanofab Management and Technicians

The Nanofab Management and Technicians are responsible for the day-to-day operations of the Nanofab. The Nanofab Manager reports directly to the CNST Director. The Nanofab Management is responsible for working with users and dealing with process related issues. The Nanofab Management is responsible for ensuring that users are properly trained on general cleanroom procedures and safety. The Nanofab Technicians are responsible for consumables, for ensuring the maintenance, repair, and installation of equipment, and for ensuring that users are properly trained on processing equipment. The Lead Technician will coordinate the activities of the other technicians. The Nanofab Management and Technicians have immediate authority regarding all aspects of safety and operation in the cleanroom.

### 2.3 Process Engineers

Process Engineers are NIST staff members and associates (contractors, guest researchers) hired by the facility to perform service processing and process development for users at an additional cost to the users.

## **2.4 User's Committee**

At its discretion, the Nanofab Manager will convene meetings of and ask for input from all users (User's Committee) so that they may provide input on issues brought to the Committee.

## **2.5 Safety Committee**

The Safety Committee will provide independent input and guidance on safety-related issues and incidents. The Safety Committee does not have line-management authority or responsibility related to safety. The Safety Committee will be appointed by the Nanofab Facility Manager. The Safety Committee will review the development of safety policies and procedures. The Safety Committee will review the development and any major modifications to equipment and the installation of any new equipment and their respective operating procedures. The Safety Committee will review all safety incidents and may assist in preparing a report on the incident.

## **2.6 Classes of Users**

### **2.6.1 Certified Nanofab User**

All NIST staff, guest researchers, and contractors are permitted to become Certified Nanofab Users. The staff of NIST's government, academic or industrial partners may be able to become a Certified Nanofab User without being a guest researcher or contractor at NIST. However, additional conditions (described in Section 3), must be met.

Certified Nanofab Users must take the necessary training and exam to enter the Nanofab. Although permitted to enter the facility, Certified Nanofab Users cannot operate equipment until being trained and checked-off by Nanofab Training Staff on that equipment.

### **2.6.2 Remote User**

A Remote User works with Facility Staff or Process Engineers and the Facility Staff or Process Engineer operates all of the equipment. A Remote User may or may not be a Certified Nanofab User.

### **2.6.3 Super User**

The Nanofab Manager may request certain users to be a Super User for specific pieces of equipment. These Super Users may be NIST Lab Staff or Nanofab Staff and would be extremely knowledgeable of a particular piece of equipment. The Super User may assist Nanofab Staff in generating/updating operating procedures, notifying Nanofab Staff of maintenance/repair needs for the tool, and training/testing new users for that piece of equipment. Super Users will generally have a deep vested interest in a particular tool, perhaps because their research depends on it.

### **3. GENERAL PROCEDURES AND POLICIES**

This section describes policies associated with the Nanofab as a whole. Only Certified Nanofab Users can independently access the facility. See 3.1 for the process to become a Certified Nanofab User. See section 3.7 regarding visitors. The policies associated with equipment and safety is given in Sections 5 and 6.

#### **3.1 New User Access and Orientation**

##### **3.1.1 NIST Staff and Associates**

All NIST staff, guest researchers, and contractors are permitted to become Certified Nanofab Users. An outline for becoming a Certified Nanofab User is given below:

- Informally discuss the project with the Facility Manager.
- Submit a project description via email to the Facility Manager. Download the form from the Nanofab website.
- Facility management will review the description and decide on whether to permit access to the facility to perform the described work. Acceptance is based on its compatibility with current projects and with the technical capabilities and available resources of the Nanofab.
- Submit a new Coral user form via email to the Facility Manager. Download the form from the Nanofab website.
- Open Coral user account by sending an Interdivision Work Order to Sharon Cook, AO, Div 812.
- The user must take the Start-up Orientation Program given periodically by the Nanofab Assistant Manager/Safety Coordinator. The Start-up Orientation Program is a 3 hour training session which covers Nanofab Safety and Nanofab Operational Procedures, and a written safety examination. Nanofab access will not be granted until the Start-up Orientation Program is accomplished and the safety exam has been completed with a passing grade.
- Upon taking and passing this program, a badge will be updated or issued that permits access to the facility. Lockers and garment hangers will be assigned to a user for the period of time that the user requires, or for one year. Locker space is limited and will be available for full-time users and high-use individuals, but will not be assigned to infrequent or one-time users unless space is available.
- The person is now a Certified Nanofab User and is permitted to independently access the facility. Certified Nanofab Users must then be trained and checked off on individual tools (see Section 5) to be able to operate the tools.
- On an annual basis, the Nanofab Manager will discuss the project with the user, update the project description if necessary, and administer an annual exam on facility safety and operating policies.

##### **3.1.2 Government, Industry and Academic Partners**

The staff of NIST's government, academic or industrial partners may be able to become a Certified Nanofab User without being a guest researcher or contractor at NIST. The Partner's organization must first submit a proposal to the CNST Director describing the overall scope of the organization's proposed work and its relationship to NIST and its mission. Details for requirements of the content of the proposal can be obtained by contacting the CNST Director. The CNST Director, in consultation with the NIST

management, and, if necessary, NIST legal staff, will determine whether the staff of the Partner's organization can use the facility. Issues to be considered include relationship of the work to NIST's mission, compatibility of the work with current projects, and cost. A separate usage fee structure will be developed for each organization. After approval of the proposal and any requisite legal agreements, staff of the Partner's organization can become Certified Nanofab User's through the process described in 3.1.1.

## **3.2 Locations**

The following section describes various locations within the Nanofab and rules regarding access by Certified Nanofab Users. See Section 7.3 for the Facility Map. See Section 3.8 regarding visitors.

### **3.2.1 Main Lobby-D101/Bldg.215**

This room is the main entrance to the Nanofab; it is room D101 in bldg 215. This room is where the controlled environment begins. This room is classified as a Class 1000 clean area. This room has the badge reader on the door and can only be accessed by authorized individuals and certified Nanofab Users only.

### **3.2.2 Locker Rooms/Pre-gowning**

There are men and women's lockers available for your personal belongings (hats, coats, cell phones, phone-cameras, PDA, notebooks, other). The locker rooms are used as the Pre-gowning areas for accessing the class 1000 corridor prior to entering main gowning.

### **3.2.3 Main Gowning Room**

This room is for final gowning before entering the Class 100 cleanroom proper. Entry is made through the second door marked "Entrance". Do not cross over to the clean area without full gowning apparel.

### **3.2.4 Cleanroom Work Bays**

#### **A.) General Wet Chemistry Bay-B101**

This bay is for all common chemistry work, not recommended for CMOS or Electronic device processing. Access to this bay is for all certified Nanofab users.

#### **B.) Clean Silicon Wet Chemistry Bay-B102**

This wet chemistry bay is dedicated to ultra-clean silicon processes. General chemistry work is prohibited and must be done in the general chemistry area. The Nanofab management and staff strictly enforce this activity.

#### **C.) Metrology Bay-B103**

This bay is open to all trained and certified Nanofab Users and is available on a first come first serve basis.

#### **D.) FESEM Bay-A101**

This bay is open to all certified Nanofab users who have been trained and authorized to use this equipment by the Nanofab Manager.



**E.) Optical Lithography Bays (Photo 1 and Photo 2)-A102 and A103**

These two bays are open to all certified Nanofab users who have been trained and authorized to use this equipment by the Nanofab Manager.

**F.) E-beam Lithography Bay-A104 and A101**

These two bays are open to all certified Nanofab users who have been trained and authorized to use this equipment by the Nanofab Manager.

**G.) Metal Deposition Bay-B104**

This bay is open to all certified Nanofab users who have been trained and authorized to use this equipment by the Nanofab Manager.

**H.) Dry Etch Bay-B105**

This bay is open to all certified Nanofab users who have been trained and authorized to use this equipment by the Nanofab Manager.

**I.) Oxidation and Diffusion Furnaces and CVD Bay-B106, B107**

This bay is open to all certified Nanofab users who have been trained and authorized to use this equipment by the Nanofab Manager.

**J.) Open Class 100 Bays-A105, A106**

These bays are being held for future NIST partners or NIST collaborations related to nanotechnology.

**K.) Service Chases**

These areas contain mechanical, electrical and other ancillary equipment, and is not to be accessed from the cleanroom proper by Nanofab Users. Nanofab users can enter these areas from the Class 1000 corridors in order to place materials into the appropriate pass-through for retrieval from the cleanroom.

**L.) Sub-fab-215 Basement**

This area is restricted, and can only be accessed by Nanofab staff and authorized NIST Plant personnel.

**M.) Hazardous Material Cut-Off Room-E05**

This area is restricted and can only be accessed by the Nanofab Staff.

**N.) Chemical Storage-D106**

This area is where the process chemicals are stored and this room is open to all certified Nanofab Users.

**O.) Phones-Cleanroom**

Phones are located inside the cleanroom along the walls at the end of the bays near the center hallway.

#### **P.) Chemical Pass-thru**

These are designed as air-locks for passing items (chemicals and other materials) into the cleanroom from outside. Access to a specific pass-thru is done from the class 1000 corridor, and entering into the respective service chase for that particular pass-thru. Use the proper pass-thru for the material that you are using.

#### **Q.) Chemical receiving room-D107**

This room is where the chemicals are received. They are brought up from the basement using the dumb waiter, wiped down, inventoried, and transferred into the two way chemical closets for storage in the chemical storage room.

### **3.3 Nanofab Entry and Exit**

#### **3.3.1 User Entry**

Entry into the cleanroom is for Certified Nanofab Users and Nanofab Staff only. Access is restricted, and can only be obtained if the user has followed the requirements in section 3.1.1. Unless leaving the facility due to an emergency, users shall never enter the equipment corridors or chases without first contacting facility staff.

- The certified user will enter the Nanofab through Bldg. 215, room D101.
- Users must log-in and out of the cleanroom computer upon every entry and exit. This allows the facility staff to monitor who is in the cleanroom at all times. The Coral Software System for managing user entry, equipment use and authorization is described in Section 5.
- After successfully logging in, the user can enter the appropriate locker room (men or women). The locker room is for personal belongings. Hair covers, gloves, face masks and booties are required beyond the locker rooms in the Class 1000 gowning room, equipment chases, and corridors.
- The gowning area is where the critical clean area begins, and can be entered through the automatic doors. Clean room etiquette and contamination control is given in the next section.
- The following provides the gowning procedure:
  1. The locker rooms are the pre-gowning staging areas.
    - Put on:
      - Hair net
      - Face Mask
      - Shoe covers
      - Latex gloves
      - Safety Glasses
  2. When entering or exiting the gowning area, always use the door to your right.
    - Select gown, hood and boots. Begin to dress from top down.
    - Pull hood over head, and adjust.
    - Step into coverall, and tuck hood into coverall.
    - Put on rubber sole boots and tuck coverall into boots. Adjust.

- Check yourself in the mirror to ensure there are no gaps in your suit.
  - Swing legs over bench into clean area.
  - Enter the cleanroom through the automatic sliding door.
- 3. Safety glasses must be worn at all times.
- 4. Do not wear open toe shoes or sandals when working in the facility.
- 5. After gowning, do not loiter in the gowning room; do not store your materials (i.e. wafer boxes, cleanroom notebooks, or other supplies) in the gowning room. Enter the cleanroom through the automatic door, and proceed to the work stations. Log into tool computers.
- To exit the work stations and Nanofab, the following procedure shall be followed:
  1. Log out of tool computer.
  2. Exit cleanroom through the gowning room automatic door.
  3. If you are done for the week, place your garment into the garment hamper and exit the gowning room through the door marked “Exit”. If you are returning to the cleanroom in the same week, hang your garment on the garment rack for use when you return.
  4. Exit to the appropriate locker room.
  5. Discard your pre-gowning supplies, and retrieve your personal belongings.
  6. Exit the locker room into the Nanofab Lobby and log out on the Nanofab Computer. Exit the Nanofab.

### **3.3.2 Samples, Supplies, and Equipment Entry**

- The Nanofab Manager must be contacted PRIOR to bringing ANY chemicals, equipment, or questionable items into the facility.
- Personal equipment such as cell phones, camera-phones, digital cameras, PDA’s, notebook computers, magazines, books, etc. CANNOT be brought into the cleanroom but can be stored in pockets or in the locker room.
- Samples (wafers, wafer containers, etc.) MUST be cleaned using Propanol-2 and approved cleanroom wipes in the lobby of the cleanroom prior to entering the facility. If you feel that your samples cannot be cleaned prior to facility entrance, contact the Nanofab Manager. The proper process for cleaning samples prior to cleanroom entrance is covered in the user orientation.

## **3.4 Cleanroom Etiquette and Contamination Control**

The Nanofab is a Class 100 Cleanroom (Fed. Std. 209E). The following rules are based on accepted Class 100 protocols:

- No person, whether certified or not, shall enter the cleanroom unless their physical presence is necessary.
- Personal items that cannot be stored easily in pockets are not allowed.
- Bulky clothes, furs, angora, linty stockings or similar types of clothes are not allowed.
- Clothing minimizing the amount of bare skin is required.
- No cosmetics of any kind are recommended.
- Adequate personal hygiene is required.

- Persons suffering from colds, flu, allergies, and similar illnesses should avoid entering the cleanroom.
- Clean shoes and clothes are required.
- Damaged or dirtied gloves and garments shall be replaced immediately.
- New cleanroom garments shall be used weekly.
- The Nanofab Manager must be contacted prior to bringing any chemicals into the facility.
- Always wear all required gowning as described in 3.3.
- No foam, paper, cardboard or wrapping and packaging material are allowed.
- No paper, except approved cleanroom paper or approved encased paper products, is allowed.
- No tobacco products, spitting, eating, drinking and gum chewing.
- No wooden items are allowed.
- No pencils, felt tips, magic markers or erasers are allowed. Only approved cleanroom pens are allowed (supplied).
- No abrasives such as steel wool, emery cloth or sandpaper are allowed.
- No trash is allowed on the floor and trash shall be immediately put in the appropriate dispenser.

### ***3.5 Hours of Operation***

- Unless otherwise notified, the Nanofab will be open from 7:00 AM to 7:00 PM. Nanofab staff may not be available after hours (Staff Hours: 8:00 to 5:30)
- All tools can be operated out-of-hours except for:
  - LPCVD/PECVD
  - Wet chemical processing (PR spin and develop may be performed out of hours)
  - Metal RIE-Chlorine
- Out-of-hours policy:
  - The user must contact the Nanofab Manager ahead of time to schedule out of hours work.
  - The user may be given specific responsibilities for out of hours work.
  - The user must wear the emergency call personal safety device.
- Should the Nanofab be closed due to laboratory conditions or other problems, the main entry doors to the facility will be locked, a sign will be posted on the main door, an email will be sent to the users and unauthorized entry is not permitted.

### ***3.6 User Communication***

- All issues that pertain to the Nanofab, including closures, emergency situations, equipment failure and repair, will be posted by email.
- Please reference your email frequently enough to ascertain that the lab is safe for entry and the equipment is operational and accessible.
- Signage will also be used in the event an individual cannot access their email accounts.

### ***3.7 Facility Governance and Appeals***

- The Nanofab Management will consult with the Nanofab Staff, Safety Committee, Nanofab Safety Coordinator and users prior to pursuing any changes to the policies set forth in this manual.
- The Nanofab Management and Nanofab Staff have immediate authority on all issues and equipment.

- A decision by the Nanofab Management or Nanofab Staff can be appealed to the Nanofab Director.
- Failure to follow rules or directions of the Nanofab Management or Nanofab Staff can result in suspension of privileges for any time frame to be determined by the Nanofab Management.

### **3.8 Visitors**

- A visitor is defined as ANY person entering the facility who is not a Certified Nanofab User or Nanofab Staff.
- The Nanofab Manager must be notified when a visitor wants to enter the facility.
- The Nanofab Manager or Staff will provide the visitor with a short visitor safety presentation.
- Visitors must be escorted at all times by a Certified Nanofab User or Nanofab Staff, and are the sole responsibility of this individual.
- Visitors may observe work, but should never operate any equipment including processing equipment, chemical processing or measurement tools.
- Visitors are restricted from touching or moving materials or items in the Nanofab.

### **3.9 Acknowledgements and Publications**

- All output including, but not limited to, publications, presentations, reports, test structures, reference materials, and reference data, involving work performed wholly or partially at the Nanofab, must acknowledge the facility and its sponsors. Please use the following format:

“This work was performed in part at the NIST Center for Nanoscale Science and Technology Nanofab that is partially sponsored by the NIST Office of Microelectronics Programs.”

- If the Nanofab Manager or Nanofab Staff contributed in a significant way to the accomplishment of the reported research, then consideration should be given to including the staff as co-author(s). This is most appropriate if the project involved the development of special processing technology by the staff. If you have any questions on who should be included as co-author(s), please do not hesitate to contact the Nanofab Management.
- Copies of publications resulting from your work at the Nanofab should be given to the Nanofab Manager as soon as they are published. In addition, if at any time during your research at the Nanofab you have interesting results, please informally communicate these to the Facility Staff.

### **3.10 Intellectual Property**

The Nanofab and its staff are not responsible for the protection of intellectual property. If protection of your intellectual property is important, do not share it with staff or users. The use of the facility and its equipment requires some knowledge by facility staff of your samples and process conditions. If you do not feel that you can share information required by the facility or necessary to document equipment operation, you will not be permitted to perform this work.

#### 4. USAGE FEES

The following provides a description of the usage fees for NIST Staff and Associates (as defined in 3.1.1). Usage fees for NIST partners (as defined in 3.1.2) may follow a different schedule as determined by the Nanofab Management.

All NIST Staff and Associates using the Nanofab are charged usage fees. The usage fees permit entrance to and use of the facility subject to training on individual tools. The usage fees are used to pay for consumables, maintenance, and facility staff. Users are charged an hourly rate for entering the facility and an additional hourly rate for using tools. The hourly rate for entering the facility includes use of wet chemistry, and metrology tools (Ellipsometers, Reflectometer, Profilometer, Optical Microscopes, 4-point Probe). The hourly rate for using the Nanofab and tools are given in the table on the following page.

An individual or group of individuals must create an account (through an interdivision work order) that will be charged on a per hour basis. When a Certified User logs into the facility or onto a particular tool through the Coral Software System the user will be asked to enter the account number to charge. The user must log onto the Coral Software System for a particular tool prior to performing any work and log off of the Coral Software System for that particular tool after all work (including shut down and cleans as dictated) is completed on that tool. The Coral Software System will not allow a Certified User to log into the facility or onto a particular tool if there is no balance remaining on the account. The user is responsible for ensuring that a positive balance remains on the account. Accounts may carry-over no more than xx% of the total usage for that account in the current fiscal year to the next fiscal year.

Remote Users that have Nanofab Staff perform service processing are charged the per hour user fees that the Nanofab Staff incur when using the facility for the remote project plus an additional hourly rate for the Facility Staff time. The Remote User should first meet with the Nanofab Manager to discuss plans. This initial consultation is free of charge. Based on this initial consultation, the Nanofab Manager will generate an estimated cost for the service processing. The Remote User will issue an interdivision work order for the estimated cost. Nanofab Staff will then perform the service processing.

*\*\*See Nanofab Website for current prices at <http://nanofab.cnst.nist.gov>.*

## 5. EQUIPMENT

### 5.1 Operating Procedures

- All equipment in the facility (including chemical processing and inspection tools) has an operations manual describing the procedures and limitations of the equipment. This will include the types of samples that may be put into the tool.
- Nanofab Staff are responsible for the development and revision of equipment operating procedures.
- ANY use or operation of equipment that falls outside of the procedure described in the operating manual must first be discussed with the Nanofab Manager.
- The Nanofab Manager will base decisions to authorize a change in operating procedure proposed by a user on the recommendations of the user, Safety Committee (if applicable).
- Operating procedures for particular tools can be obtained from the Nanofab Manager, or the Nanofab website (<http://cnst.nanofab.nist.gov>).

### 5.2 Approved Users and Training

- Users must contact the appropriate Nanofab training staff or management to become trained to operate equipment.
- The Nanofab Technician or Nanofab Manager, or a tool user authorized by the Nanofab Manager may train a new user on a particular tool.
- However, a new user must be formally tested and authorized by a Nanofab Technician or the Nanofab Asst. Manager to be approved to independently use a particular tool.
- A list of authorized tool users for particular tools is posted on the facility web site (to be developed). The Coral Software System will allow only approved users to log-in to the tool.

### 5.3 Scheduling

- An authorized tool user must reserve equipment for both training and usage.
- Tools are reserved using the Coral Software System described in 5.4.
- If a user is not using the tool during the reserved time (within 30 minutes), another user may access the tool without reservation.
- Failure to cancel an unneeded reservation is inconsiderate to other users and causes inefficient utilization of resources. It is realized that all projects require a certain process flow between tools so that one problem can throw off your entire schedule. Also, processes can take longer than expected. Thus, while we encourage you to sign up ahead, we also encourage you to be flexible and cooperative with other users in stretching, sharing, and relinquishing time slots.

### 5.4 Coral Software System

*Please see the tutorial at [http:// cnst.nanofab.nist.gov](http://cnst.nanofab.nist.gov) to learn how to use Coral*

- Reserving (either a multi-day or multi-machine view) of equipment in order to better share scarce resources among the members of the laboratory.
- Software enabling and disabling of equipment to generate records of equipment use for billing purposes.
- Support for maintaining lists of qualified users for each piece of equipment and for checking that each lab member is properly qualified to enable any given piece of equipment.

- Support for reporting and displaying equipment problem and shutdown conditions and for returning that equipment to normal service following repair by maintenance personnel.
- Interface for adding new users to the system and for controlling projects and accounts to which their laboratory use will be allocated.
- Mechanisms to allow staff members to charge users for equipment used on their behalf and to independently re-charge their time to users.
- Optional interlock hardware to prevent normal operation of equipment unless it has been enabled.
- Optional collection of runtime process information (such as number of wafers processed, deposition material and/or thickness, etc.).

### ***5.5 Introduction, Installation, Modification, and Repair***

- ANY introduction, installation, modification, or repair of equipment must be FIRST discussed with the Nanofab Management.
- The prioritization of installation, modification, or repair of equipment will be addressed by the Nanofab Management.

### ***5.6 Consumables, Regular Maintenance, and Standard Test Runs***

- The Facility Technicians are responsible for replenishing of consumables, regular equipment maintenance, and performing of standard test runs.
- The Lead Facility Technician may delegate authority to specific users to replenish consumables, provide for regular equipment maintenance, or perform standard test runs.
- The Facility Technicians have procedures and schedules that describe and track consumables replenishing, equipment maintenance, and standard test runs.

### ***5.7 Equipment Resources***

This section includes a general description of the capabilities of each processing tool and includes what kinds of materials can go in each tool, wafer sizes, etc. The operating manuals for each tool are not a part of this document.



Tool	Sample Size	Capability	Restrictions	Tool ID	Room #
Tystar ATM Furnaces	3", 4", 6" wafers	Wet/Dry SiO <sub>2</sub> , Diffusion, Solid source doping, Anneal	Tool C is for CMOS and Ultra clean silicon only!	B,C	B106
Tystar LPCVD	3", 4", 6" wafers	Polysilicon, Silicon Nitride, Low Temp Oxide	Silicon only	A	B106
Modular Process Technology RTP	4", 6" wafers	Rapid thermal Anneal. Forming Gas, Argon, Nitrogen, Oxygen		E	B105
Unaxis PECVD	Samples to 10" substrates	Low temp: Polysilicon, Silicon Oxide, Nitride	Silicon only	D	B106
Unaxis Silicon RIE	Samples to 10" substrates	Thin Film etching: SiO <sub>2</sub> , Poly, Nitride, Organics	Silicon only	F	B105
Unaxis Metal RIE-Fluorine	Samples to 10" substrates	W, Au, Cu		G	B105
Unaxis Metal RIE-Chlorine	Samples to 10" substrates	Al		J	B105
Unaxis Deep Silicon Etch	Samples to 10" substrates	Deep Silicon etching	Silicon only	I	B105
Xactix XeF <sub>2</sub> Silicon Etch	Samples to 6" wafers	Isotropic silicon etching, High silicon selectivity		H	B105
Denton Thermal Evaporator	2", 3", 4" and 6" wafers	Al		K	B104
Denton Thermal and E-Beam Evap.	2", 3", 4" and 6" wafers	Au, Cr, Ti, Ni, Ag, Fe, Al, Cu		M	B104
Denton Sputter	2", 3", 4" and 6" wafers	SiO <sub>2</sub> , Au, Cr, Ti, Ni, Cu		O	B104
CVC Evaporator	3", 4" wafers	Au, Cr, Ti, Ni, Ag, Co, Hf		L	B104
Myers Dry Evaporator	Samples to 6" wafers	Au, Ti, Al (Oil-free vacuum system)	Dedicated to Molecular Electronics research	N	B104
Woollam M-2000 Ellipsometer	Up to 6" wafers	Thin film measurement		P	B103
Nanospec Nanospec	Samples to 4" wafers	Thin film measurement		Q	B103
Dektak 6M Profilometer	Samples to 6" wafers	Step height and stress analysis		R	B103
Rudolph Ellipsometer	Samples to 4" wafers	Thin film measurement		S	B103
Nikon Microscope	Up to 6" substrates	Inspection, image capture		Z	B103
4-point Probe station	Any size, up to three inches thick	Resistivity, doping measurements		AA	B103
Jeol 6400 SEM/E-beam	Samples up to 3" wafers	Inspection and lithography		V	A104
Suss MicroTec Contact Aligner-MA6/BA6	2" 3", 4" and 6" wafers	Lithography (0.75um) I-line, G-line, UV-400. Backside Alignment. Wafer-to-wafer bond alignment.	Avoid touching or moving backside scopes.	T	A102
Suss Microtec Contact Aligner-MA8/BA6	6" wafers	Lithography (0.75um) I-line, G-line, UV-400. Wafer-to-		U	A102

		wafer bond alignment.			
HTG Mask Aligner	2", 3", 4" wafers	Lithography (1-2 um) I-Line, G-line		W	A103
Zeiss FESEM	Samples to 6" wafer	Inspection		CC	A101
Leica VB-300-UHR E-beam Lithography	Up to 6 " (300mm Capable)	10 Wafer Air-Lock, Resolution < 4 nm, Linewidth < 10 nm			A101
Disco 341 Wafer Dicing Saw	Small pieces to 8" wafers.	Silicon, Sapphire, Ceramic, Quartz		TBA	TBA
PVA Tepla Microwave Asher	Pieces up to 25 8" wafers	Removes hard baked photoresist, SU-8, etc. Also release of MEMS structures without Stiction.	CF4 requires ceramic chamber		105B
Tousimis Critical Point Dryer	Up to 8" wafer	MEMS			
Focused Ion Beam					

## 6. SAFETY POLICY

- Contact ext. 2222 with emergencies
- A separate Safety Manual describes the details of safety rules including chemical safety, gas safety, and emergency response.
- The Safety Manual can be obtained from the Nanofab Manager or facility web site.
- The staff and management of the Nanofab have implemented all reasonable measures to ensure that the laboratory provides a safe working environment.
- It is the responsibility of all users, visitors, and staff to act in a safe manner at all times while in the facility.
- Safety rules and policies set forth in this manual and the Safety Manual are no substitute for common sense. Operating safely is more important than getting your project, or anything else, done. Ignorance of the rules, lack of common sense, language difficulties, carelessness, and haste are not adequate excuses for unsafe behavior.
- The Nanofab Manager and Nanofab Staff have immediate authority on all safety issues.
- Users violating the safety rules of the facility or endangering the safety of themselves or other users may be denied further access to the facility at the discretion of the management.
- All Certified Nanofab Users will take and pass an annual safety and policy exam administered by the Nanofab Assistant. Manager.
- The Safety Committee will review the development and any revision of the Safety Manual and equipment operating procedures, and all other areas where safety is a concern.
- The Safety Committee will review all safety incidents and will assist in preparing a report on the incident.

## 7. APPENDIX

### 7.1 Names and Contact Information

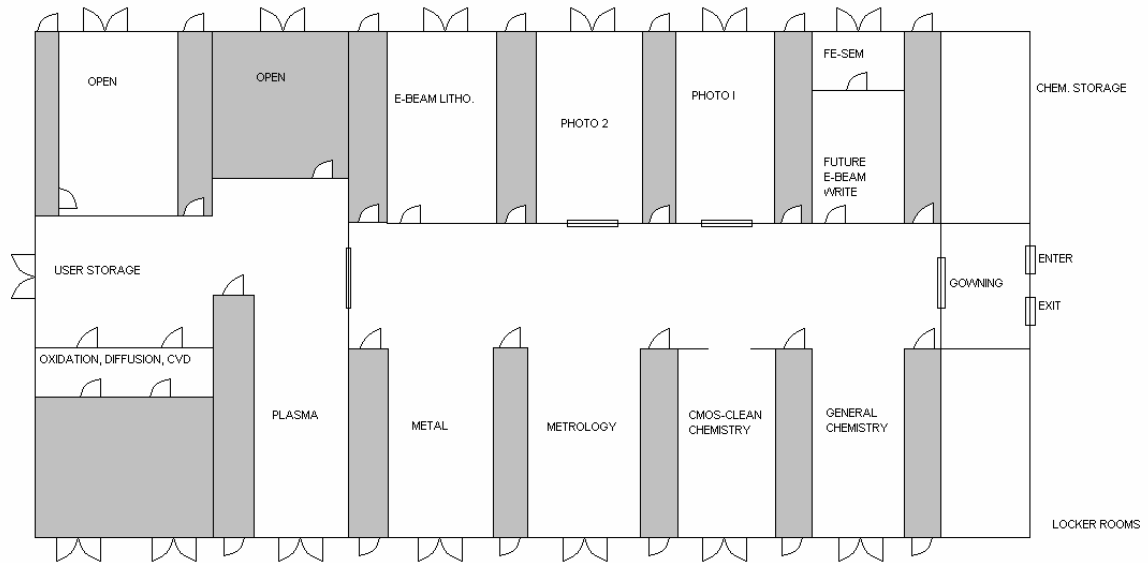
<b>Title</b>	<b>Name</b>	<b>Ext.</b>	<b>E-mail</b>	<b>Office</b>
<i>CNST Director</i>	Robert Celotta	8001	<a href="mailto:robert.celotta@nist.gov">robert.celotta@nist.gov</a>	216/A221
<i>Nanofab Manager</i>	Gerard Henein	5645	<a href="mailto:gerard.henein@nist.gov">gerard.henein@nist.gov</a>	217/A239
<i>Nanofab Asst. Manager</i>	Russ Hajdaj	2699	<a href="mailto:russell.hajdaj@nist.gov">russell.hajdaj@nist.gov</a>	217/A247
<i>Facility Technicians</i>				
	Jim Owen	5623	<a href="mailto:james.owen@nist.gov">james.owen@nist.gov</a>	217/A241
	Larry Buck	2242	<a href="mailto:lbuck@nist.gov">lbuck@nist.gov</a>	217/A243
<i>Process Engineers</i>	Marc Cangemi	5993	<a href="mailto:mcangemi@nist.gov">mcangemi@nist.gov</a>	217/A255
<i>Safety Committee</i>	Russ Hajdaj (Nanofab Safety Coordinator)	2699	<a href="mailto:russell.hajdaj@nist.gov">russell.hajdaj@nist.gov</a>	217/A247
	James “Mike” Blackmon (Environmental Safety)	5822	<a href="mailto:mike.blackmon@nist.gov">mike.blackmon@nist.gov</a>	301/B122
	Dennis Myers (NIST Occupational Health and Safety) Division)	5823	<a href="mailto:dennis.myers@nist.gov">dennis.myers@nist.gov</a>	301/B122

## **7.2 Approved Nanofab Chemical List**

**(For Additional Information on Chemicals, Please see the CNST Nanofab Safety Manual)**

2-propanol  
Acetic Acid  
Acetone  
Aluminum Etchant  
Ammonium Hydroxide  
Ammonium Peroxidisulfate  
Buffered Oxide Etch  
CR7 Chromium Etchant  
CR9 Chromium Etchant  
Helium  
Hexamethyldisilazane  
Hydrochloric Acid  
Hydrofluoric Acid  
Hydrogen Peroxide  
Methanol  
Microposit 1165 remover  
Microposit 351 Developer  
Nitric Acid  
Oxygen  
PAE Etchant  
Phosphoric Acid  
Potassium Hydroxide  
RS 100 Photoresist Stripper  
Silicic Acid  
Silicon Etchant  
Sulfuric Acid  
Tetramethylammonium Hydroxide, 25%  
Xenon Difluoride  
Ammonia Gas  
Dichlorosilane  
Forming gas  
Hydrogen chloride gas  
Hydrogen Gas  
Nitrogen Gas  
Oxygen Gas  
Silane  
Ethyl Alcohol  
Methyl Alcohol  
Oxygen  
Xylene

### 7.3 Nanofab Location Map



## 7.4 Nanofab User Work Proposal Form

<u>Nanofab Users Name:</u>	<u>Supervisor Name/ Extension:</u>
<u>Laboratory:</u> (circle one) EEEL, MSEL, MEL, BFRL, CSTL, PL  <u>Division:</u>	1) NIST Employee ____ Yes ____ No  2) Guest Researcher ____ Yes ____ No  3) Other: _____  <u>Expected Start Date:</u>
<u>Bldg./Office:</u>	<u>Expected End Date (Optional):</u>
<u>Extension:</u>	<u>Email Address:</u>
<u>Project Name/Description:</u>  <u>Describe in brief detail the work you intend to conduct in the Nanofab:</u> _____ _____ _____ _____ _____ _____ _____ _____ _____ _____ <u>Explain why the Nanofab is required to do above research:</u> _____ _____ _____ _____ _____ _____ _____ _____ <u>What equipment will be utilized to do the work described above:</u> _____ _____ _____ _____ _____	